ASSESSMENT OF ISSUES AFFECTING THE PROPER PRACTICE OF HEALTHCARE WASTE MANAGEMENT SYSTEMS IN LAE'S ANGAU MEMORIAL GENERAL HOSPITAL: AN AHP APPROACH

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Abstract - Healthcare Waste Management still remains as one of the major challenges for Healthcare Facilities in developing countries like Papua New Guinea (PNG) to address in the effort to match world standards. Since healthcare wastes are hazardous in nature, correct practices for its management such asproper handling, treatment, and disposal of this waste is seen as a necessity to prevent the spread of diseases and infections. Healthcare facilities in PNG need to isolate areas of priority within their facility as a step forward in order to fully adopt the World Health Organisation (WHO) standard for proper healthcare waste management system. A better strategy and planning is important to improve the efficiency and effectiveness of healthcare waste management in these facilities. A multi-criteria decision making technique, Analytical Hierarchy Process (AHP), which utilises a multi-level hierarchical structure consists of objective, criteria, pairwise comparisons of these criteria and alternatives is applied in theassessment of various factors affecting implementation ofappropriate healthcare waste treatment technology. The input from various medical experts has been used in a pairwise comparison matrix in order to rank the issues relating to healthcare waste management. The results of the study could behelpful in prioritizing the course of action to address these issue effectively.

Keywords - Papua New Guinea (PNG), Angau Memorial General Hospital (AMGH), Healthcare Waste Management (HCWM), Healthcare Facilities (HCF), Healthcare Waste (HCW), Analytical Hierarchy Process (AHP).

I. INTRODUCTION

PNG is struggling in recent years solely to meet the medical needs of its people. Much of the country's citizens are rurally situated without adequate supply of medical resources. Many of the Healthcare Facilities (HCF) in the country which are government-operated are old, run-downed and are limited in resources. Due to this fact, most of these HCFs only focus on the primary objective of delivering medical supplies and to restore good health to the sick and injured. In doing so, these HCF overlook some of the medically sensitive issues like the practice of proper Healthcare Wastes management within their facility. Healthcare Wastes means any solid, fluid, or liquid waste including its containers and any intermediate product which is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities that are considered harmful and infectious. (Sharma, A. K. 1998). Majority of waste (75-90%) produced by the HCF is non-risk or general and it is estimated that the remaining (10-25%) of healthcare waste is regarded as hazardous and has the potential for creating a variety of health problems. (World Health Organization, 2005). AMGH on average produces about 5kg-7kg of healthcare waste per ward daily, but despite the efforts for the management of wastes, the current system of healthcare waste management in hospital is seen to be inadequate and risky. There is a dire need of immediate attention and improvement and to develop a national policy and implement a comprehensive action plan for HCWM providing environmentally sound technological measures to improve HCWM in PNG. Therefore, finding the best and effective technology system based on multi-criteria decision making tools is important for the development of a comprehensive action plan to establish a proper healthcare waste management system.

II. LITERATURE REVIEW

The health care waste issue scenario is becoming worse day by day as a remarkable rise in the generation of health care waste has been observed throughout the world owing to the tremendous growth in population and the resultant increase in number as well as size of HCUs, and use of disposable health care products, (Gupta et al., 2012). Hence, to make certain that the negative impact of health care waste on the ecology and the public health is maintained to a minimum it's proper management is warranted(Thakur and Ramesh, 2015). Realising the hazardous nature of healthcare waste, several developed countries have woken up to address this

threat, and the HCUs of these countries have adopted many commendable positive steps(Chaerul et al., 2008). This in turn has attracted researchers from various countries to carryout studies on HCWM issues.

Faisal and Farooqi(2010) studied interactions existing among barriers of hospital waste management and identified a total of 13 barriers and investigated the structural interrelationship existing among them employing ISM. Muduli and Barve(2012) also attempted to investigate barriers of HCWM in Indian HCUs and their interrelationship employing ISM approach. In another study Thakur and Anbanandam(2016) explored 25 barriers of HCWM practices in the context of Indian HCUs and represented them in a hierarchical structure employing ISM approach. Later, Swain et al.,(2017) studied various challenges to waste management policies in Indian health care units. Their study explored 14 challenges which were further analyzed employing grey relational approach to evaluate their degree of influence on HCWM practices. Delmonico et al.,(2018) conducted on barriers of waste management practices in hospitals of Brazil employing a case study followed by AHP based analysis of these barriers.

Review of literature shows that a good number of studies analyzed barriers of HCWM. Few studies also analyzed enablers of waste management practices in HCUs. However, analytical studies that consider enablers and barriers simultaneously are scarce. Enablers are the factors that encourage HCWM implementation and proper attention to these factors may help in reducing the impact of few barriers. Hence, this study is conducted to analyses the enablers and barriers simultaneously.

In this regard 12 enablers and 15 barriers has been identified from literature which has been presented in table-1

Table-1 Enablers and barriers of HCWM as identified from literature review.

	Enabler(Internal)Strength	
E1	To improve patient satisfaction	Mathur et al., 2012;
E2	Reduction in landfill capacities	Muduli and Barve, 2012
E3	Profitable business opportunities	Muduli and Barve, 2012
E4	Consolidation of market share	Swain et al., 2017
E5	Employee Pressure	Muduli and Barve, 2012
	Enabler(External)Opportunities	
E6	Regulations from the legislative bodies	Muduli and Barve, 2012
E7	Availability of Advanced Technology	Muduli and Barve, 2012
E8	Pressure from socially responsible groups	Thakur and Anbanandam, 2016;
E9	Support and Initiatives from Various Organizations	Muduli and Barve, 2012
E10	Awareness and training programs	Thakur and Anbanandam, 2016
E11	Competitive pressure	Swain et al., 2017
E12	Sustainable Development Practices	Swain et al., 2017
	Barrier(Internal) Threat	
B1	Lack of Segregation Practices	Manga et al., 2011;Mishra et al., 2018,
B2	Inappropriate Waste Management Operational Strategy	Thakur and Anbanandam, 2016; Mishra et al., 2018
B3	Lack of Green Procurement Policy	Thakur and Anbanandam, 2016;
B4	Unauthorized Reuse of Healthcare Waste	Muduli and Barve, 2012
B5	Lack of Accountability of Authorities of HCFs on HCWM	Swain et al., 2017
B6	Financial Constraints	Muduli and Barve, 2012
B7	Poor Regulative Measures	
B8	Resistance to Change and Adoption	Swain et al., 2017

B9	Lack of Awareness among patients, attendants, and people at large	Mishra et al., 2018
B10	Less Priority to Waste Management issues and Policies	Swain et al., 2017
	Barrier(External) Opportunity	
B11	Insufficient Support from Government Agencies	Muduli and Barve, 2012
B12	Lack of Adequate Waste Treatment Facilities	Mishra et al., 2018
B13	Inadequate Awareness and Training Programs	Swain et al., 2017
B14	Lack of Strict implementation of Infection Control measures	Biswal et al., 2015
B15	Lack of coordination between municipality and hospital authorities	Gupta et al., 2012

III. METHODOLOGY

The Analytical Hierarchy Process (AHP)

AHP was developed by Thomas Saaty (1980), and is useful for decision-makers in formulating and analysing decisions. This method begins with coming up with pairwise comparisons and allows the relative assessment and prioritization of alternatives. Then these comparisons are weighted and from the weights, criterion can then be prioritised and ranked. This method is used in numerous publications and has become a popular research method in various fields for assessing, rating, and determining the importance weightings for selection indicators or criteria.

Steps in AHP:

Hierarchy Formation, Pairwise Comparisons, Evaluation of Consistency and finally Evaluation of Weights

Applying AHP to Healthcare Waste Management at Lae's AMGH

The basic procedure is as follows:

1. Develop the ratings for each decision alternative for each criterion developed in the questionnaires regarding possible solutions to the issue by:
    - Developing a pair wise comparison matrix for each criterion.
    - Normalizing the resulting matrix.
    - Averaging the values in each row to get the corresponding rating.
    - Calculating and checking the consistency ratio.
2. Develop the weights for the criteria by:
    - Developing a pairwise comparison matrix for each criterion.
    - Normalizing the resulting matrix.
    - Averaging the values in each row to get the corresponding rating.
    - Calculating and checking the consistency ratio, ideally less than 0.1(10%)
3. Calculate the weighted average rating and set them as Priorities for each decision alternative. Choose the one with the highest score and rank them.

IV. RESULTS AND DISCUSSIONS

Table 2: Ranks of Internal Reasons for Adopting a Proper HCWM Practice.

Category	Priority	Rank
To improve patient satisfaction	51.8 %	1
Reduction in landfill capacities	24.1 %	2
Profitable business opportunities	5.1 %	5
Consolidation of market share	5.7 %	4
Employee Pressure	13.3 %	3

In Table 2amongst the internal reasons for the hospital to adopt a proper HCWM practice, the resultsuggests that To Improve Customer/Patients Satisfaction is the most appealing reason amongst medical officers.This is evident on-ground as these medical officers work day and night to get ill patients to their state of wellbeing. Since AMGH is a centrally large general hospital, a lot of people from far and wide, within or outside the province come to access medical services at this hospital. Therefore, the medical officers can be seen performing their duties with the chief objective of improving the health conditions of their patients.

In second, Reduction in Landfill Capacities, which as seen from some of the photos presented earlier, there is currently no proper and enough space for storing wastes. This exposes the harmful contents to nearby environment and people. The current storage space is

not isolated at a location that is further from medical wards but it is just on a block in between other hospital departments. The risk of the spread of infections, diseases, odour and other pollutants is therefore high. In third is Employee Pressure, which is seen as social force affecting the performance of medical officers which in turn affects the quality of services they deliver. In order to meet the medical needs which is of demand in this struggling economy of PNG, healthcare workers have to work more around the clock, and this adds pressure on them and consequently adding pressure on the hospital management as well. The affecting issues contributing to employee pressure may vary from the increase in number of patients requiring treatment in any one time to the shortage of medical supplies in the hospital. All of which adds not only physical but also psychological stress on these workers who are just as human like all of us. Continued pressure can lead to underperformance and an unhealthy state of mind for these medical workers.

The remaining reasons are more inclined to the business and financial undertakings of the hospital. Such reasons as share of market and profitable business opportunities are not really important factors to be reasons to adopt a better HCWM practice as AMGH is a government-run hospital in which the cost of receiving medical assistance for curable diseases is less compared to privately-run hospitals in the city. Since the government has implemented the free-healthcare policy in 2014, the cost of general medical services has reduced as seen across the country's major hospitals and clinics. Although privately-run hospitals slightly offer a better and faster service, the cost of these services are higher compared to government-run hospitals and there is not really a competition as much of the population are middle-class, low income earners, and from the rural areas. More number of people in all provinces access government-run hospitals and they are seen as the lifeline for the populaces.

Table 3: Ranks of External Reasons for Adopting a Proper HCWM Practice.

Category	Priority	Rank
Regulations from the legislative bodies	17.8 %	3
Competitive pressure	4.5 %	7
Awareness and training programs	19.0 %	2
Societal Concern for Environmental Protection	10.0 %	4
Availability of Clean Technology	6.4 %	6
Support and Initiatives from various Organisation	35.7 %	1
Sustainable Development Practices	6.7 %	5

Table 3presented above suggests that Support and Initiatives from Various Organizations is the most appealing external reason (35.7 %) amongst medical officers for the Hospital to adopt a proper HCWM practice. AMGH has received support from various aid organisations through the years. One foundation which frequently provides support and initiatives is the AusAid foundation, which is the biggest donor agency to PNG and has been offering aid to this hospital as well as other various hospitals across the country. In fact, the country's healthcare has been immensely supported by the AusAid foundation through medical assistance and various tangible projects. Other big donors are the Japanese Government and New Zealand Aid which have also contributed meaningfully towards the hospital's development. The second most appealing reason isSocial Pressure and this can be linked to the numerous populaces from all around Morobe Province as well as other provinces seeking medical treatment which collective adds pressure on the healthcare workers. In third, as indicated by the medical officersRegulations from Legislative Bodies is a motive for them to adopt a proper HCWM practice. But upon observations, there is barely signs of regulations as some facilities no longer conform to the regulatory standards.And if there is no regular inspections conducted, this can prolong the problem of HCWM and prevents the adoption of new practices and technologies. External reasons ranked 4, 5, and 6 concerns the environment and sustainable practices by the hospital. It is important that any service delivery operation such as medical services hold regard the integrity of the environment and monitors any impacts such operations can have on it. Due to the effects of climate change felt around the world, many countries are now taking a bold stand in the efforts to minimize further contributors towards the problem. The use of clean technology, environmental sustainable development practices within the hospital enhances the quality of service, resource availability, and instill an overall atmosphere of advocating safe work practices to minimize the risk to nearby communities and the environment.

Table 4: Ranks of Internal Barriers preventing the Adoption of a Proper HCWM Practice.

Category	Priority	Rank
Lack of Segregation Practices	5.4 %	8
Improper Waste Management Operational Strategy	7.4 %	6
Lack of Green Procurement Policy	7.2 %	7
Unauthorized Reuse of Healthcare Waste	2.6 %	10
Lack of Accountability of Authorities of HCFs on HCWM	10.2 %	4
Financial Constraints	13.1 %	2
Poor Regulative Measures	7.7 %	5
Reluctance to Change and Adoption	3.4 %	9
Lack of Awareness among patients, attendants, and people at large	32.5 %	1
Lesser Prioritization to Waste Management issues	10.6 %	3

In Table 4amongst the list of internal barriers impeding the proper practice of HCWM, Lack of Awareness among patients and attendants is ranked as top (32.5 %) amongst medical officers. From surveys and dialogues between various healthcare workers, it was observed that there is lack of awareness amongst patients, medical workers, and the general public. Most of the medical officers who participated in the survey had trouble comprehending some of the questions presented to them and these officers have little awareness of the correct practice of HCWM. The current practice of just separating medical waste in one bin and general waste to another is perceived by medical officers and patients as satisfactory and fairly safe. The importance of identification and segregationis not respected since there is little to no awareness amongst staff, patients and the general public.

Financial Constraints is ranked second, being identified as one of the major factor inhibiting the proper practice of HCWM. The hospital relies mainly on the government to successfully administer the delivery of adequate medical services. The challenge is real as it is obvious that the hospital is doing whatever it can to adequately meet the medical needs of the people in this struggling economy. To meet these needs, some of the important practices can be overlooked and be given lesser priority.

The internal barriers rankedfrom 4 to 7highlight the order of importance of the issues that need attention from the hospital board and other relevant authorities.There is signs of lack of accountability from relevant authorities in the hospital, especially towards the handling, treatment, and storage of all types of waste. As observed, no proper signs or posters, worker ambiguity, and improper protective equipment are clear signs of lack of accountability, poor regulative measures, and weakstrategy. Although ranked eighth in importance, the current practice of segregation which seems accepted by many medical officers is not proper and has its risk. Many believe that the current practice of waste segregation is satisfactory and thus does not require attention for improvement or change. All medical wastes in all wards are disposed into a single bin which are later separated by sanitary officers after collection.The problem with this is that the wastes may not be separated well according to their risk sensitivity and the workers could get infected easily.
Although there is segregation practice in place, there is still risk involved in handling wastes especially to the workers who are at the tail-end of waste management; those who come into direct contact with the wastes before they get disposed or incinerated. Also, inadequate supply of color coded containers, lack of guideline for healthcare waste management, and low commitment of HCWs were observed. Many of the hospital staff are willing to see changes taking place and are willing to adopt new technologies that will improve their service delivery and importantly be safe for the people and the environment.

Table 5: Ranks of External Barriers preventing the Adoption of a Proper HCWM Practice.

Category	Priority	Rank
Insufficient Support from Government Agencies	10.4 %	4
Lack of Adequate Waste Treatment Facilities	12.9 %	3
Inadequate Awareness and Training Programs	48.4 %	1
Lack of Strict implementation of Infection Control measures	3.7 %	5
Lack of Coordination between municipality and authorities	24.5 %	2

In Table 5 above, it is indicated by many medical officers that Inadequate Awareness and Training Programs is the most impeding external barrier (48.4 %) deterring the proper practice of HCWM. From surveys and dialogues amongst various healthcare workers, it was observed that there is lack of awareness amongst these workers certainly due to lack of training and short courses.

Ranked in second, Lack of Coordination between municipality, Pollution Control Board, and the hospital Authorities(24.5 %) has been identified as one of the major factors inhibiting the proper practice of HCWM. In order to address various issues within the hospital, these relevant parties need to work together to ensure all functions are performed well. Close coordination by the infection control board, the hospital management and the higher authority of the health department is a legal necessity in dealing with problems identified by the hospital board and external groups such as this research is targeting.

The third most impeding external barrier is the hospital does not have proper storage spaces or buildings for storing wastes before disposal. Garbage bins and bags at the incineration site are left out in the open to await transportation and this has potential to cause the spread of diseases and it is also a public eye-sore to people who normally would expect the hospital to be clean and orderly. The old incinerators is a factor delaying the total disintegration of waste matter and thus need to be replaced.

Insufficient Support from Government Agencies and Lack of Strict implementation of Infection Control measures come in the ranks 4 and 5 in which few hospital staff believe that there is sound funding provided by the government and that there is sign of infection control measures taking place in the hospital and that the current practice of HCWM is fairly acceptable. But these few staff members are

identified to work in a position where they do not usually get to see in direct the issues of improper HCWM on ground. Such workers for example are those who work in the labs, the pharmacy, and the administration.

CONCLUSION

The application of the multi-criteria decision-making technique: Analytical Hierarchy Process (AHP) has proven useful in this research in identifying which issues in HCWM needs attention. The results will be helpful for the decision-makers in relevant authorities in addressing various issues relating to HCWM and even other areas as well. Overall findings of this study indicated that the current treatment and handling of HCWs did not follow the recommended HCWM practice set by WHO. Furthermore, the current healthcare waste management practice in AMGH was managed improperly and can pose great risk to human health and the environment. Now with various issues surrounding the practice of HCWM at hand, the authorities will need a comprehensive plan to address these issues as funding and time are crucial in today's economy. To assist in decision-making to determine which issues to address by importance, the AHP method as demonstrated earlier has proven effective and thus can be a guideline for those in power to specifically provide the energy and support in attending to the issues in a timely manner and avoid any redundant effort such as overspending. It is therefore recommended that the results from this analysis be followed by the relevant authorities of the hospital with accompanying guideline documents on the knowledge of healthcare waste types, diseases transmitted with contact of infectious wastes, and standards of practice for the improvement of the HCWM practice and overall healthcare service in the AMGH.

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